ENERGY CONSERVATION DEMONSTRATION POTENTIAL IN THE FOOD AND BEVERAGE INDUSTRY IN NEW BRUNSWICK

Co-generation Associates, Ltd.

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Canada/New Brunswick Conservation and Renewable Energy Demonstration Program

The Conservation and Renewable Energy Demonstration Program Program is administered in New Brunswick by the Energy Secretariat and managed jointly with Energy, Mines and Resources Canada. The Program is designed to help demonstrate promising conservation and renewable energy technologies, to develop public awareness and understanding of these technologies, and to create employment in new or existing industries.

Through over 100 demonstration projects in New Brunswick, a wide variety of conservation and renewable energy technologies have proven to be technically sound and economically attractive. These demonstration projects should now provide a catalyst for commercialization and lead to widespread adoption of many of these proven technologies.

This final report is based on a project which was financially supported by the Energy Demonstration Program. For further information on other demonstration projects funded in New Brunswick under this program, contact:

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Programme Canada/Nouveau-Brunswick de démonstration des économies d'énergie et des énergies renouvelables

Le Programme de démonstration des économies d'énergie et des énergies renouvelables est administré au Nouveau-Brunswick par le Secrétariat à l'énergie, en collaboration avec Energie, Mines et Ressources Canada. Ce programme tente d'abord de vérifier la fiabilité des techniques de conservation d'énergie, d'accroître la sensibilité du public envers ces techniques et, enfin, de favoriser la création d'emplois au sein des industries nouvelles ou déjà existantes.

Un grand nombre de projets de démonstration se sont avérés à la fois techniquement réalisables et économiquement attrayants.

Le succès ainsi rencontré encourage la commercialisation des procédés les plus accessibles. Cela entraînerait certes l'adoption d'un grand nombre de ces techniques par les propriétaires de domiciles et par l'industrie privée.

Ce rapport final est basé sur un projet qui a reçu une aide financière du Programme de démonstration. Pour de plus amples renseignements, communiquez avec la:

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1.0 EXECUTIVE SUMMARY

1. Cogeneration Associates Limited were engaged to identify two demonstration projects in the Food and Beverage industry which would be suitable for CREDA financing, and to assist the selected plants in preparing a proposal.

2. A survey of thirty-two (32) establishments was undertaken by means of a mail questionnaire and plant visits. Nineteen (19) projects were identifed which showed pay-back periods of from 2 to 5 years.

3. Two projects, Connors Bros. and Carapec Ltd., were selected for further study and detailed proposals were prepared.

4. Connors Bros. submitted a proposal for funding and were successful in obtaining 65% of the total capital cost of $202,000 as a contribution from the CREDA program to demonstrate the following:

    a) Hot air recovery
    b) Hot water recovery
    c) Electricity Load Management

    The total energy saving of the undertaken project will be $80,000/year, giving a pay-back period of 2.5 years on the total cost of the project.

5. Carapec Ltd. also expressed interest in a demonstration project, for which a detailed proposal was prepared. However, with the rapid rise in interest rates in 1982, the project was abandoned.

6. Other conservation of energy projects within the Food and Beverage industry in New Brunswick, with pay-back periods of between 2 and 5 years, exist today, but management is not willing to invest in projects which do not yield pay-back periods of less than 2 years, and in some cases, less than 1 year.

SOMMAIRE-RECOMMANDATION

1. Cogeneration Associates Limited s'était engagé à identifier deux projets de démonstration dans le secteur des boissons et aliments dont le financement serait acceptable en vertu de l'A.D.E.E.E.R. et à aider les entreprises choisies à préparer une proposition.
2. Un sondage a été entrepris auprès de 32 (trente-deux) entreprises au moyen d'un questionnaire envoyé par la poste et d'une visite des lieux. On identifia alors 19 (dix-neuf) projets offrant un recouvrement de 2 à 5 ans.
3. Deux de ces projets, ceux de Connors Bros. et de Carapec Ltd., furent mis à l'étude et donnèrent lieu à la préparation de propositions détaillées.
4. Connors Bros. soumit une proposition qui lui valut une subvention de 65% du coût total de 202 000 $ de l'investissement dans le cadre du programme de l'A.D.E.E.E.R. en vue de démontrer:
    a) la récupération de la chaleur de l'air
    b) la récupération de la chaleur de l'eau
    c) la gestion de la charge d'électricité

    Les économies totales en énergie pour le projet susmentionné seront de l'ordre de 80 000 $/an, soit un recouvrement de 2,5 ans du coût total du projet.
5. Carapec Ltd. se montra également intéressé à la réalisation d'un projet de démonstration et prépara une proposition détaillée.

Cependant, en raison de la hausse rapide des taux d'intérêt en 1982, le projet fut abandonné.

6. Le secteur des boissons et aliments au Nouveau-Brunswick recèle encore d'autres projets d'économie de l'énergie, présentant un recouvrement de 2 à 5 ans, mais la direction des entreprises hésite à investir dans des projets dont le recouvrement ne soit pas inférieur à 2 ans, ou même à 1 an.

2.0 INTRODUCTION

In 1980 the purchases of fuel and electricity by the Food and Beverage industry in New Brunswick were valued at $21,577,000., representing 10.3% of the total spent by the Manufacturing industry. The cost of energy to the Food and Beverage industry was 6.8% of the value of shipments for that industry. In that year, about 4,446,000 GJ of various types of energy was consumed to heat factory space, to melt, heat, cook, boil and sterilize products, to move materials, and to operate computers and control systems. Therefore, energy is vital to the competitive health of this industry in New Brunswick.

Concern expressed by the Food and Beverage industry in the past few years over energy supply and prices have prompted many plant managers to direct their attention to the efficiency with which energy is being used in producing goods and services. This is especially true in this industry where energy is one of the significant input factors of production. Since the price of most fuels is determined outside of New Brunswick, industry is attempting to hold down the total cost of energy by using it at higher efficiency. This increasing efficiency in energy use is being accomplished by many methods, some of which are as follows:

- Improved housekeeping and maintenance;
- Use of new materials or improved and more efficient processes and equipment;
- Recycling of materials;
- Modification of existing equipment;
- Reduction of energy losses in boilers, ovens, steam pipes, retorts, etc;
- Use of cogeneration;
- Recovery of waste heat from industrial processes and the effective utilization of it to reduce fuel purchases.

Various programs have been introduced by both the provincial and federal governments to assist industry through energy audits. Two of these programs are the Atlantic Energy Conservation Investment Program (AECIP), and the Conservation and Renewable Energy Demonstration Assistance Program (CREDA). As part of this activity in the energy field, the provincial government has authorized Cogeneration Associates Limited to identify projects which can demonstrate new energy saving technology for use by industry in New Brunswick.

3.0 OBJECTIVES OF THE STUDY

The objectives of this study were as follows:

1. Identify two demonstration projects to be funded under the Federal/Provincial demonstration program;

2. Assist in preparation of proposals and requests for funding;

3. Inspect the two projects on behalf of the Energy Secretariat until the end of their demonstration phase;

4. Prepare final report.

4.0 METHODOLOGY

New Brunswick has about 142 establishments which are classified under the Food and Beverage Industry. A list of these establishments was obtained from Scott's Industrial Directory, and a sample of 32 establishments was selected. (Appendix C) This sample contained representation from each of the major groups of industries operating in New Brunswick which are as follows:

- Meat & Poultry Products
- Fruit and Vegetable Industries
- Dairy Products
- Feed Industry
- Bakery Products
- Beverage Industry

A simple one-page questionnaire was sent to this list of companies to determine their energy use levels and to obtain some indication of waste heat streams with their temperature and flow characteristics.

After a review of the responses from the mailed questionnaire, the following plants were visited by an engineer in July 1981:

Company	
1. Connors Bros.	- Black's Harbour
2. Carapec Ltd.	- Caraquet
3. L'Association Co-operative des Pecheurs	- Lameque
4. Ocean Maid Foods	- St. Andrews
5. National Sea Products	- Shediac
6. Moosehead Breweries	- St. John
7. Canada Packers	- Sussex
8. McCain Foods	- Florenceville

For each plant visited, possible energy saving projects were identified, and calculations were made to indicate the feasibility of such projects. Two companies, Connors and Carapec, showed interest in submitting an application for funding for the identified projects.
Both of these were waste heat recovery projects which could demonstrate some of the technology which is briefly outlined in the next section of this report.

5.0 WASTE HEAT RECOVERY

5.1 Technical Review

In the on-going search for energy conservation, industrial and commercial establishments are looking to squeeze more useful energy out of their purchased fuels. They are increasing the efficiency of their energy generating equipment through better control and technical design, and through recovery of energy from the existing waste heat streams.

Waste heat recovery offers the greatest potential for manufacturing plants to reduce their consumption of purchased energy. Waste heat is energy which is rejected into the atmosphere by thermal process. It can be in the form of hot liquids or gases, ranging in temperature from 80°F to 1500°F. It is rejected by refrigeration systems, cooling towers, furnaces, process ovens, dryers, condensers and boilers. Although the energy is there, its ability to do useful work is dependent on its quantity, quality, and match to process requirements.

Energy quantity is related to flow, and is measured in terms of BTU's or Joules, depending on which language you speak. Energy quality is more or less a function of the absolute temperature of the waste heat stream. Therefore, the terms quality and temperature can be used interchangeably.

In order to recover energy, there are two types of heat transfer equipment used. These can be classified as passive and active devices. Passive devices are heat exchangers which rely on temperature gradient for heat transfer. In this case, the quality of energy must be greater in the source of heat than in the application. However, there are many potential applications for heat recovery in the manufacturing industry where the reverse is true. The temperature of the waste stream is often cooler than that of the energy application site. This indicates that an active device such as a heat pump must be used for energy exchange.

In commerce, the main sources of heat are boiler stack gases and ventilation air. In industry, there are many sources, related both to the space heating of plants and factories and to industrial processes.

A recent study on Waste Heat Recovery Pontential by the Department of Energy, Mines and Resources has estimated that out of the total fuel consumption in New Brunswick's Fish Processing industry of 4.4×10^6GJ/yr (Table 5.1) about 2.45×10^6GJ is rejected (33%). The distribution by temperature of this waste energy is as follows:

Table 5.1

ESTIMATED REJECTED ENERGY IN FOOD AND BEVERAGE

Group	°F	10^6 GJ	%
A	500 - 1500	.4	16
B	212 - 500	.7	29
C	120 - 212	.05	2
D	Less than 120	1.3	52
		2.45	100

Group A & B waste heat figures consist mostly of energy contained in gases rejected by the boilers. The waste heat streams in groups C & D are mostly hot liquids (water, oil, chemicals, etc.) which are used for cooling industrial processes, equipment or products. It can also be steam condensate which is not returned to the boiler. Ventilation heat rejected from buildings is also in this group.

The above table shows that the greatest opportunity of waste heat recovery is in Group D with it incurring 52% of the total heat wasted. Next in magnitude is Group B with 29%.

Almost all manufacturing establishments eject heat into the environment. The recovery of this heat for useful purposes is determined by the economics of installing waste heat recovery equipment, and the availability of technical expertise and operating manpower.

The temperature and quality of rejected heat streams vary considerably between industries and even between companies in the same industry, depending on the specific complement of industrial processes and equipment. However, there are only three principal sources of rejected heat:

1. Combustion equipment which exhausts flue gases at relatively high temperatures:
   - 500 - 1500°F kiln flue gases
   - 350 - 500°F boiler flue gases
2. Process losses, generally liquids at moderate to low temperatures:
   - 120-212°F condensate and process water
   - lower than 120°F condenser cooling water
3. Gas turbines and diesel engines which have high temperature gases, exhausts and cooling water streams.

In general there are six steps required to implement a heat recovery project. They are as follows:

1. Identify the quality and quantity of waste heat stream; Assess the technical feasibility of the stream;
2. Determine the uses for the recovered heat and its time of use; Prepare the heat balance calculation on a time scale;
3. Specify heat recovery equipment, a transportation system, and storage if required;
4. Calculate the economic feasibility of the proposed heat recovery system;
5. Purchase and install equipment;
6. Prepare operating and maintenance manual and schedule.

5.2 Technical Considerations

Each energy recovery system is largely unique and site-specific, requiring a variety of equipment connected by a system for transferring, and possibly storing heat energy. Many industrial plants lack the necessary energy demand

characteristics for recovering rejected heat, due to variations in operating procedures or to the small volume of waste heat involved.

Furthermore, heat energy usually has a low energy content per unit of volume compared to other energy sources such as fossil fuels. For this reason it may be technically more complicated to accomplish within a plant, due to the larger volumes involved. Space and routing limitations in a retrofit situation may be a particular problem.

Industrial operations which are considering the utilization of waste heat recovery techniques will have to consider a number of technical factors such as:

Quality: Waste heat streams which are extremely corrosive to heat exchangers and other equipment are not suitable for recovery. Only clean, non-corrosive, and relatively safe streams can be considered at this time. Others must wait for suitable equipment and techniques to be developed.

Quantity: Waste heat streams are often too small or too dispersed to be economically collected and recovered. A large volume from a single source is the ideal situation.

Heat Balance: The ability to match the source of heat and its use is a key factor. Re-scheduling of operations or energy storage may be necessary to achieve a level energy load. In cases where this is not possible within an industrial plant, conversion to another form of energy, such as electricity or compressed air, may help to provide an internal use or to find a market outside the plant boundary.

Personnel: Qualified operators, supervisors, maintenance and managerial personnel are necessary for the successful implementation of a waste heat recovery system.

Monitoring and Control: Accurate metering devices and efficient control systems will be an important component of an efficient, safe, and reliable energy cascading system operation.

The recovery and re-use of waste heat involves a balance of requirements. The reliability factor requires that considerable care be taken not to make the plant operations unnecessarily complex. Back-up energy sources and systems may be necessary to ensure availability in case of shut-downs or other disruptions. The energy transfer system must be sound, since the breaking down of an item such as a heat exchanger could result in contamination of process fluids, equipment or products. Optimizing the design and performance characteristics of each unit's operation, as well as the total system, is the overall key to success.

5.3 Source of Waste Heat

5.3.1 Boiler Flue Gases

All fired boilers require combustion air and produce flue gases. The flue gases are usually in the 400° to 600°F range. This temperature can be reduced by removing heat for combustion air preheat or for heating water in an economizer. In the past, manufacturers of boilers produced combustion systems which reject flue gases over 500°F to reduce the corrosion in boilers.

A problem develops as the economizer pressure mounts to reduce the stack temperature below its acid dew point. For this type of application, corrosion cannot be avoided even by using expensive, exotic alloy tubing. It must be accepted that source steel, like fuel, will be consumed in the process.

Economizers remove heat from the moderately low temperature combustion gases after the gases leave the steam-generator. Economizers are forced-flow, once through, convection heat transfer devices, usually consisting of steel tubes. Hot water produced by this type of heat exchanger can be used as feedwater to a boiler, or for other applications.

The size of an economizer is governed by economic considerations involving the cost of fuel, the capital cost, the thermal performance, the relative cost of air heaters, the hot water temperature, and the desired flue gas temperature. The temperatures of the economizer tube metals generally approximate those of water in the tubes.

The tubes, therefore, can be at temperatures where condensation can take place. Since most of the fuels used in New Brunswick contain various amounts of sulphur, corrosion of the economizer may take place when flue gas is cooled below the dew point by recovering too much energy from the gas.

Air heaters, like economizers, remove heat from the flue gases. The heat recovered from the combustion gases is recycled to the furnace with the combustion air, resulting in a gain in overall thermal efficiency. The use of preheated combustion air accelerates ignition and promotes rapid and complete burning of the fuel.

Corrosion of air heaters is a problem where the flue gas temperature is reduced below 300°F. However, the best way to deal with the corrosion problem is to take it into consideration during the design stage, and provide a separate corrosion section arranged to facilitate the replacement of the vulnerable cold-end portion. An air preheater can save between 10% to 30% of the fuel used in a boiler.

5.3.2 Heat Recovery from Hot Liquids

Many industries, and especially the Food and Beverage, the Chemical Products, and the Petroleum Products industries, reject large quantities of heat in their processes. In most cases this energy is contained in water which is used as a cooling medium.

In the processing of food, hot water or steam is used for cooking, pasteurizing, cooling and cleaning. In dairies, recovered hot water can be used for preheating milk in pasteurizers, for clean-up water, or for preheating the boiler make-up water.

The waste heat stream is usually in the 90°F to 150°F range. In many cases the rejected hot water contains contaminants such as food solids, which requires additional processing or filtering before the heat can be recovered. Liquid/liquid heat exchangers can be used to transfer the heat in the waste stream to preheat either the process water or the product.

The difficulty arises when the waste heat production is not in phase with the heat demand. In this case, storage facilities for hot water must be provided, from which the hot water can be distributed to the appropriate applications.

Another source of heat in the food and beverage industry is that produced in the condensers of the refrigeration equipment. The cooling water from condensers is at about 90° to 120°F, and it is clean. It can be used directly in the plant, or the temperature can be elevated by a heat pump to between 160° to 180°F. At this temperature most of the cooking and pasteurizing equipment can be supplied with this water. Evaporators and cooling towers can also provide energy for heat pumps.

5.4 Equipment for Heat Recovery

5.4.1 Heat Pumps

The major manufacturers of packaged industrial high temperature heat pumps in North America are Westinghouse Electric Corporation and Carrier Corporation. Figure 6.1 shows a schematic diagram of a Westighouse product called "the Templifier". The heat pump cycle is the same as the refrigeration cycle except that the temperature levels have been changed.[10] This requires the use of different refrigerants. The heat pump is capable of recovering low grade waste heat in the temperature range of 16°C to 49°C. The waste heat from the source water is absorbed in the evaporator by the refrigerant. The temperature and pressure is increased by the compressor. From here the refrigerant goes to the condenser where its heat is transferred to process water raising its temperature up to 220°F.

A useful measure of the heat pumps effectiveness is the C.O.P. or coefficient of performance. The C.O.P. is a ratio of the heat output from the unit to the energy input to run the compressor or compressors. A C.O.P. of 4 signifies four units of useful output energy for one unit of input energy.

The C.O.P. of the Templifier unit varies depending upon the available source temperature and the required application temperature. The curves shown in Figure 6.2 describe the operating characteristics of the centrifugal Templifier heat pump. Under the conditions where the source water is 95°F (35°C), the Templifier can cool this water to 85°F (30°C) and supply hot water at 160°F (71°C) with a C.O.P. of 5.8.

FIGURE 5-1

SCHEMATIC DIAGRAM OF THE TEMPLIFIER

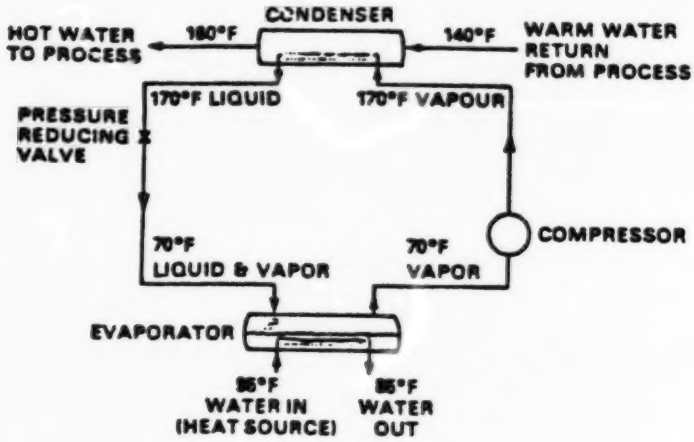
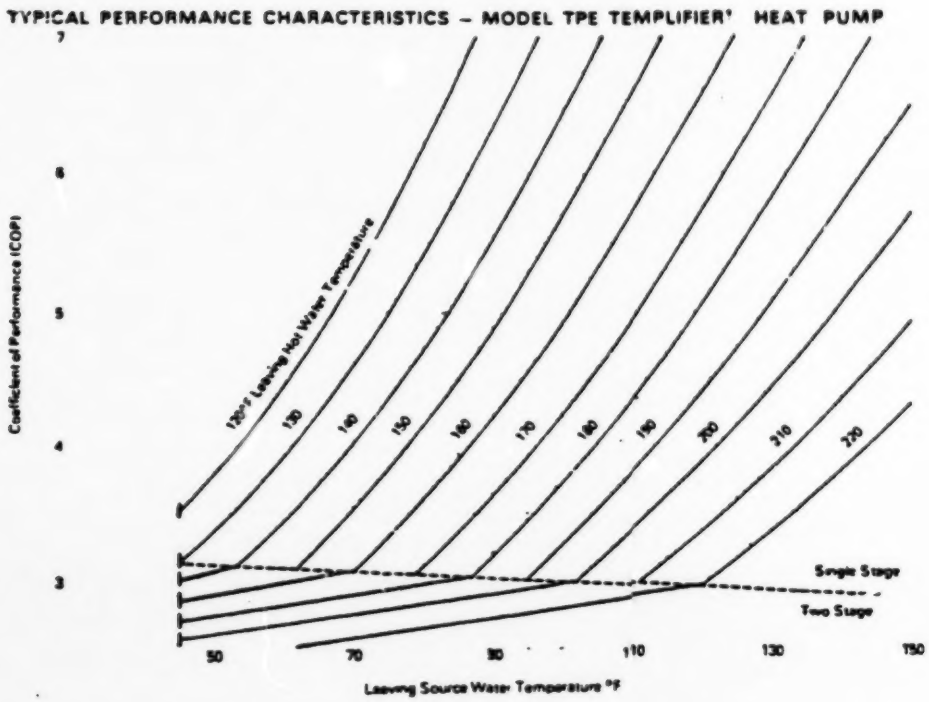


FIGURE 5-2



5.4.2 Heat Exchangers

In order to remove heat from one source and introduce it to a different one, a heat exchanger is used. Heat exchangers usually consist of nothing more than metal walls separating the two sources, which can be either liquids or gases. The amount of heat that can be transferred in a given time is proportional to the surface area of metal that each stream is in contact with and the temperature difference. By paralleling the flow of liquids in the heat exchangers the space occupied by the unit is reduced.

Fluid proportions determine the type, construction or material of heat exchanger that is most suitable. Some of the more common heat exchangers are:

(a) liquid to liquid
(b) gas to liquid
(c) gas to gas

5.4.2.1 Liquid to Liquid Heat Exchanger

Heat contained in one liquid can be transferred to another with the use of a liquid to liquid heat exchanger. Since liquids are usually under pressure it is necessary that both paths be sealed to contain the liquids. This led to the shell and tube heat exchanger, the most common type of liquid to liquid exchangers. In the process industry, shell and tube heat exchangers are in evidence in many applications because the temperatures of waste heat in liquid are relatively low, say at 25 to 35°C. To recover this energy would require large size exchangers and the resultant liquid would be at too low a temperature for economical use.

One exception to this rule is the use of low quality heat with an industrial heat pump. With this process, energy in liquid at 25 - 35°C can be recovered, increased in temperature to 80-90°C, and either used in some process or used to heat space.
The cost of heat exchangers vary according to the type, temperature difference, and material used. As the temperature of the source increases,

the cost per GJ recovered drops. For a 10 GJ/hr unit with 95°C source, the estimated cost is about $10,000, which is about twice the cost of the low pressure boiler fired with natural gas. The size of the heat exchanger surface for such a low source temperature is many times that of the boiler.

5.4.2.2 Gas to Gas Heat Exchanger

The most common application of this exchanger can be found in the recovery of heat from flue gas to preheat combustion air. Materials for heat exchangers are selected on the basis of corrosion resistance, ease of fabrication, temperature levels, strength and cost. In general up to 420°C carbon steel is used but for higher temperatures stainless steel is utilized. In Nova Scotia industries, several applications exist where hot gases can be recovered with gas to gas heat exchangers. In furnaces and boilers there is an opportunity to save energy.

A commonly used gas to gas heat exchanger, often referred to as a heat wheel, is used for recovery of low quality heat from ventilation air at 70°-90°F to preheat the make-up air for buildings and factories. The heat exchanger in this case is a regenerator. It is a cylinder about 12-14 inches high, varying in diameter from 6 to 12 feet, depending on the recovery capacity required. The cylinder rotates between the exhaust air and fresh intake air undergoing successive heating and cooling cycles and transferring heat by the termal storage capacity of the cylinder or wheel. The storage medium is fine metal wool. The working temperature determines the metal but the most common medium is aluminum and stainless steel.

This recovery system requires that all exhausts from which heat is to be recovered be brought to one location so that the total exhaust will be made to pass through one-half of the wheel. Similarily all of the supply air must be passed through the other half of the wheel before being distributed to its final destination. The transfer of heat takes place as the medium in the wheel rotates slowly through first the hot exhaust

and then through the cool supply, picking up heat on one side and giving it up on the other. Where the temperature difference is high enough, efficiencies of 80% are realized.

All wheels allow some cross-contamination to take place. Some exhaust air leaks back into the supply side through seals, the effectiveness of which is a function of the pressure difference across the ducts; some is entrained in the transfer medium and carried from one duct to the other as the wheel rotates.

Cross-contamination can be controlled by properly arranging the location of supply and exhaust fans so as to make the pressure on the exhaust side negative with respect to the supply side and by use of a purging unit. This is a small pie-shaped blind section, which causes some of the supply air to blow out or purge the trapped air in the wheel through the exhaust as each segment of the wheel passes the purging unit. Carry-over of less than 1% can be achieved with only a small loss in efficiency.

Finally, since the two ducts are located so close together, care must be taken outside the building to ensure that exhaust does not get back into the intake. This is usually done by separating them as far as possible.

Obviously then, a heat wheel can recover heat from any exhaust that can be made to pass through it.

However, the material in the wheel does limit the temperature allowable. Wheels filled with aluminum metal mesh or corrugations are limited to 300°F. Stainless steel will usually go to 600°F. Above that ceramic material is used, but even it has an upper limit of about 1500°F. At this temperature, the main problem is to find flexible material with which to seal the wheel and it is very difficult to match the expansion factors of a ceramic wheel to a steel axle and steel shell. Another limitation is size as the largest ceramic wheel is only 4 feet in diameter. The best solution is to reduce the temperature of the exhaust by mixing it with cold air to about 500° - 600°F where standard high temperature wheels can handle it very easily.

5.4.2.3 Gas to Liquid Heat Exchanger

The most common gas to liquid heat exchanger is used to recover waste heat streams to produce process steam. Equipment used for this purpose is known as waste heat boilers, and these boilers are available in a wide range of sizes. Many mineral processing plants emit large quantities of hot gases at 600-800°C from industrial furnaces, which, when passed through a waste heat boiler, produce high quality steam.

Three establishments responding to the survey have this opportunity for heat recovery.

Another application of a gas to liquid heat exchanger is known as an economizer which was described in section 5.3.1 Many respondents the survey have flue gases at 250-300°C which can utilize an economizer to recover some energy from the flue gas.

5.4.2.4 Run-Around System

All of the heat exchangers discussed above are characterized by the fact that both the medium gaining the recovered heat and the waste heat must be brought to the same place and passed through the same device. This can be awkward and expensive. The well known "run-around system" of heat recovery overcomes this problem by pumping a heated medium such as water or glycol between two heat exchangers. The exchangers which must be of the liquid type, may be placed anywhere in a building or buildings. A pump drives a transfer liquid through interconnecting pipes. Such systems must be custom designed, and while ther usefulness is readily apparent, one must be aware that their efficiency is low; less than 50%. The distance the heat can be moved is a function of the quality and quantity of heat involved and price of fuel.

At present with temperature differences of 20°C or higher between the hot and cold headers, a 10 GJ/hr system is usually economic for a distance of 200 m. A 50 GJ/hr system can move the heat economically up to 1000 m.

5.5 Cost Estimates of Waste Heat Recovery

The cost estimates for waste heat recovery systems include:

a) Capital cost (comprising equipment and installation)
b) Operating cost
c) Engineering cost

The cost associated with loss of production due to interruptions for the installation of equipment is not included. In most cases this cost is small, but such installations of equipment in the beverage industry, sugar refineries and fish processing plants may require prolonged interruption in production schedules. This would necessitate close co-ordination with the scheduled periodic maintenance periods.

In estimating the capital cost of a waste heat recovery project, the most important single item is the cost of engineering. This step will evaluate the potential source of heat, identify suitable equipment, and design the system. Evaluation of the potential can be as high as 50% of the total capital cost. Since each project is site specific, evaluation must be done from first principles. In many cases such an evaluation will prove that a particular project is not economical, and has to be abandoned. The investment in engineering has to be written off against other projects or against the operating budget. This risky initial step discourages many plant managers from undertaking such energy conservation projects.

However, if the evaluation is positive, then the subsequent steps are relatively easy and inexpensive. Locating the necessary suppliers and supplying the detailed process design is less than 10% of the total capital cost. Therefore, searching for an economic waste heat recovery project is much like searching for oil. Dry holes are very common, but the find is worthwhile.

Capital costs for various energy recovery systems were developed from cost data received from equipment manufacturers, and from our own files on installation costs. This data was compiled and presented in graph form as shown in Figures 5.3 to 5.6.

All the plants visited (as referred to in Section 4.0) were audited, and preliminary calculations were made to determine the feasibility of energy conservation. For each identified project, capital costs were estimated using the graphs in Figures 5.3 to 5.6. From the total of 19 projects, two were selected for further investigation and the preparation of proposals.

Figure 5-3

Estimated Installed Cost for
Liquid-to-Liquid Heat Exchangers

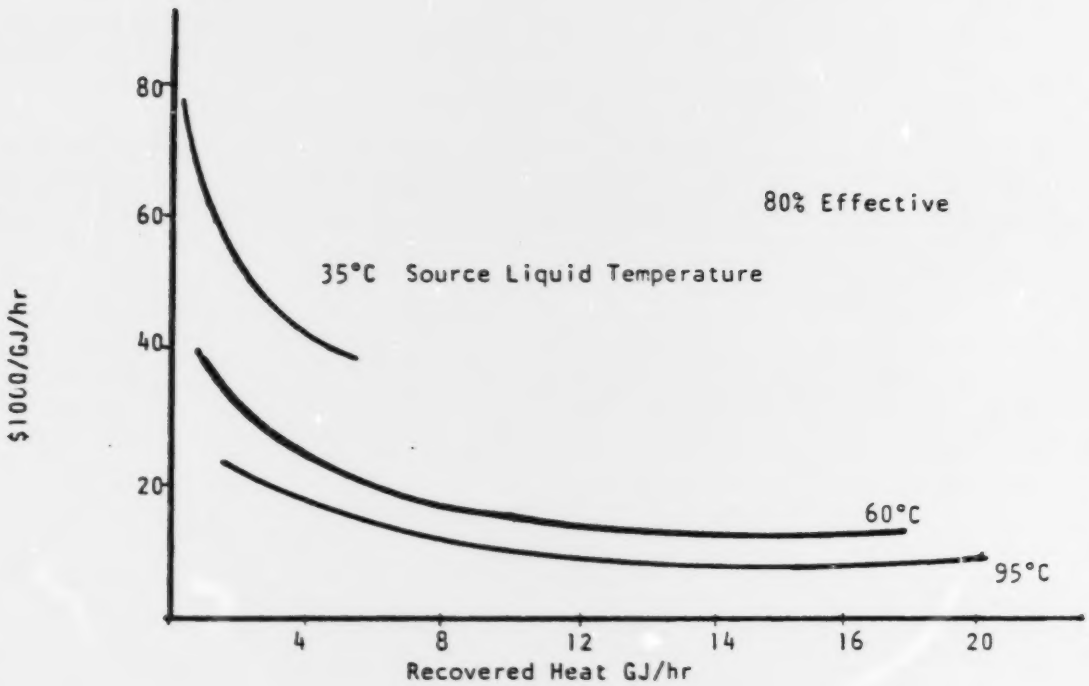


Figure 5-4

Estimated Installed Cost for
Gas-to-Gas Heat Exchangers

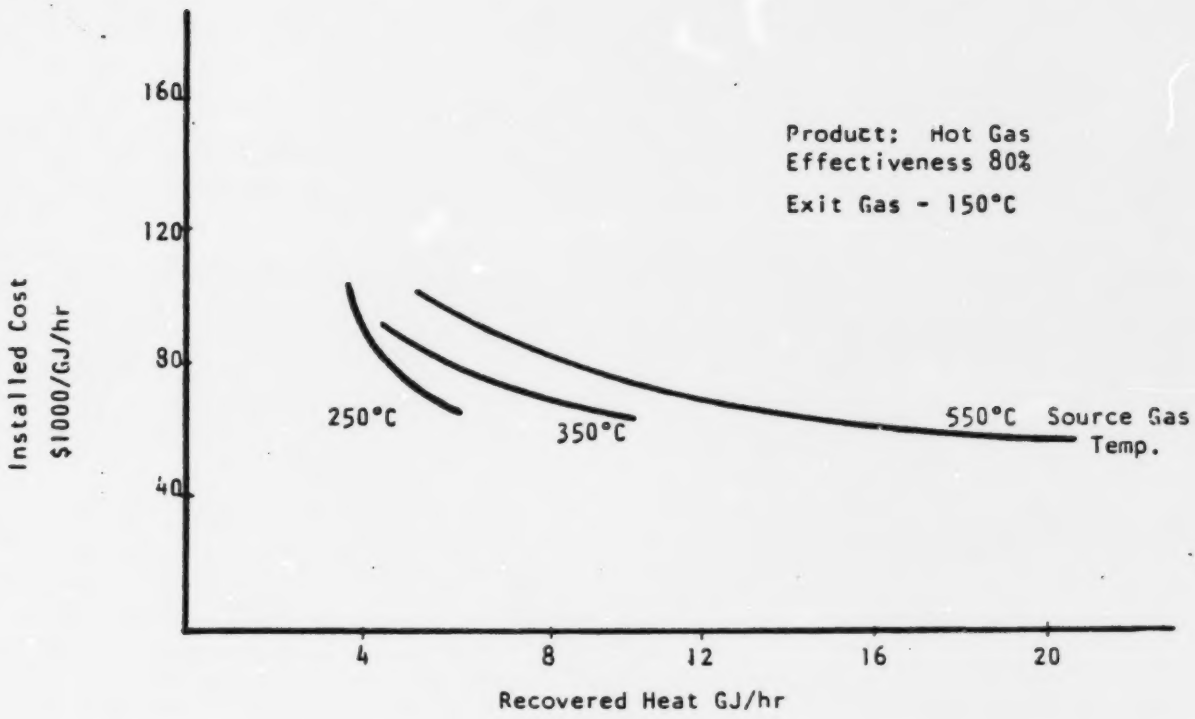


Figure 5-5

Estimated Installed Cost for
Gas-to-Liquid Heat Exchangers

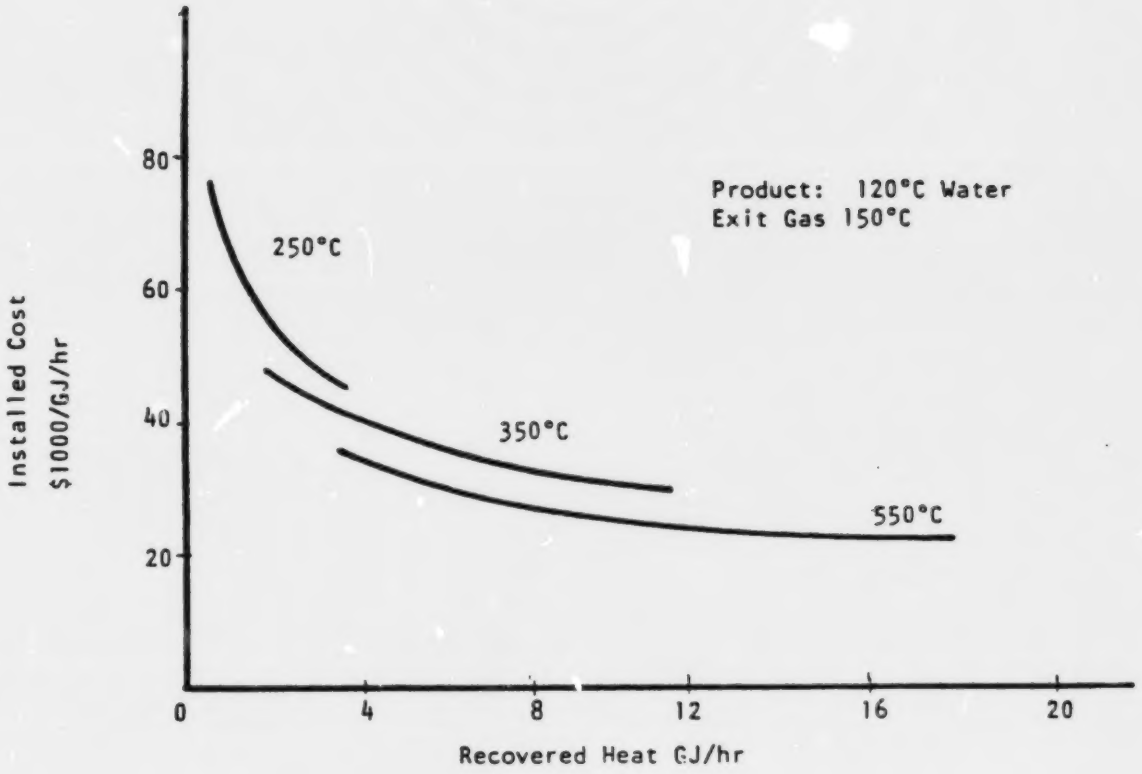
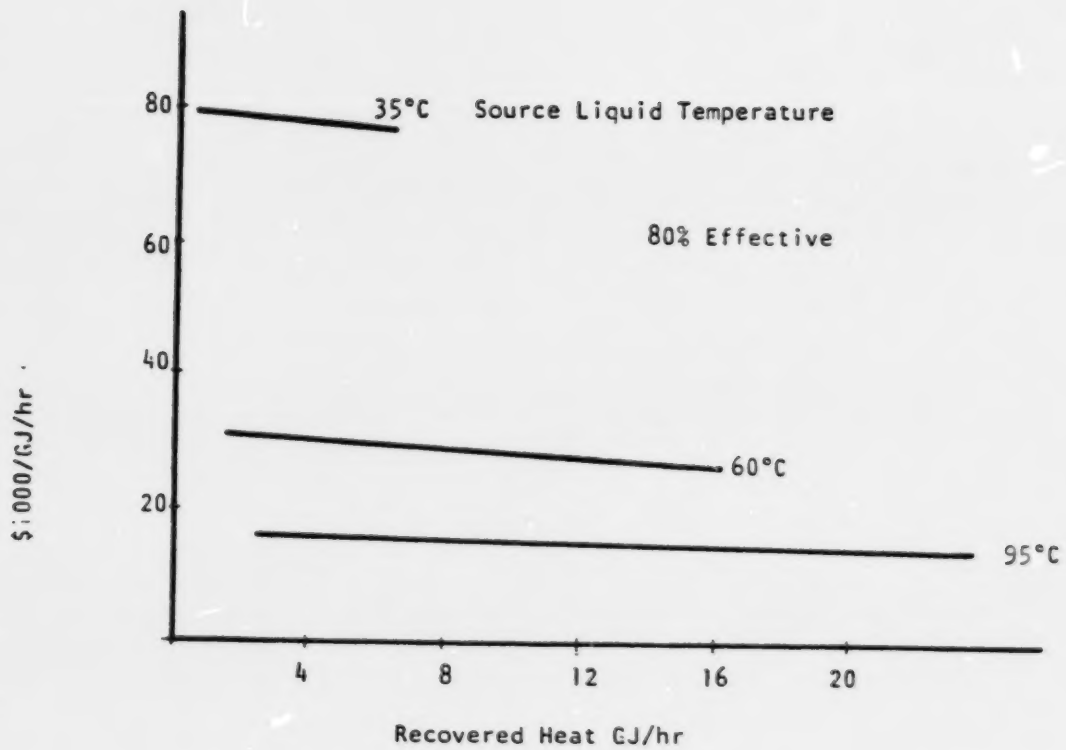


Figure 5-6
Estimated Installed Cost for
Liquid-to-Gas Heat Exchangers



6.0 PROPOSED DEMONSTRATION PROJECTS

Two projects were identified as having suitable characteristics for demonstrating heat recovery technology:

Project A - Connors Bros., Black Harbour, N.B.

- Heat recovery from hot air sources in the fish processing plant through re-circulation;
- Heat recovery from hot waste water with a plate heat exchanger.

Project B - Carapec Ltd., Caraquet,N.B.

- Heat recovery from low temperature waste water using a heat pump.

6.1 Connors Bros.

The equipment for this project was installed between March 1, 1982 and October 1, 1983. Monitoring of the energy savings began in October 1983. The company reports savings of about $80,000/year. However, this figure is based on only a 6 month period. The cost of installation is shown in Table 6-1.

In addition to heat recovery equipment, Connors Bros. have also installed computer monitoring equipment and an electrical load management control scheme.

Table 6-1

CONNORS BROS.

CAPITAL COST OF INSTALLATION

		Savings	Capital Cost
A.	Savings		
	1. Hot Air Recovery	$ 29,052	$ 18,000
	2. Hot Water Recovery:		
	a) Can washers	17,934	$ 8,000
	b) Refrigeration	4,035	15,000
	c) Tank	7,740	17,000
	SUB-TOTAL	$ 29,709	$ 40,000
	3. Electrical Load Management:		
	a) Power Factor	$ 5,453	
	b) Peak Load Shedding	13,470	
	c) Air Compressor Cycling	1,788	
	SUB-TOTAL	$ 20,711	
B.	Capital Cost - Other		
	4. Monitor & Control		$ 40,000
	5. Programmable Controller		50,000
	6. Design & Engineering		11,000
	7. Reports & Demonstration		23,000
	8. Computer Interface		20,000
C.	TOTAL	$ 79,472	$202,000

6.1.1 Waste Heat Sources - Water

There are five major sources of waste heat in the form of hot water:

- Air compressor cooling water (38°C)
- Boiler Blow-down (condenser - 93°C)
- Refrigeration system heat exchangers (32°C)
- Boiler oil preheat (condensate - 66°C)

All of the hot water sources are collected in the 5,000 gallon hot water storage tank. This hot water is used as make-up water to the boiler, and the clean-up tank. In total, 12,000 gallons/day is used for make-up and about 5,000 gallons/day for clean-up water.

6.1.2 Waste Heat Sources - Hot Air

Approximately 20,000 cubic feet per minute (cfm) of hot air was being exhausted from the plant. Approximately 12,000 cfm is now being recovered using five wall fans. These fans tranfer excess hot air from warm areas to heat cooler plant areas. The fans are individually controlled by an Allen-Bradley Programmable Logic Controller (PCL). The programmable controller uses area temperature readings as its control parameter.

This hot air directly replaces cold make-up air previously supplied to these areas and therefore reduces heating requirements.

The recovery of waste heat from hot air saved almost 5,000,000 lbs. of steam valued at $29,000/year.

6.2 Carapec Ltd.

The project at Carapec Ltd. called for the installation of a high temperature heat pump which would take heat from the refrigeration condenser water at 25°C and provide hot water at 70°C for boiler make-up and cleaning purposes. The total capital cost of such a system would be $80,000 resulting in $21,000/year in energy savings, with a pay-back period of about 4 years.

Carapec management were quite interested in this project for which a proposal for funding was prepared. However, in 1982, when the funding was requested, the interest rates for capital were in the 22-24% range, and the project was abandoned.

7.0 OBSERVATIONS

Energy conservation activity in the Food and Beverage industry in New Brunswick is being directed mostly to housekeeping and maintenance type projects which require low capital expenditures and yield pay-back periods of 6 to 8 months. For more capital intensive projects plant managers are still looking for pay-back periods of less than 2 years.

NOTE

Anyone interested in a copy of the CREDA project proposal for "Demonstration of High Temperature Heat Pump at Carapec Ltd., Caraquet, N.B." or "Demonstration of an Integrated Energy Management System at Connors Brothers Ltd., Black's Harbour, N.B.", should contact the N.B. Energy Secretariat, P. O. Box 6000, Fredericton, N.B. E3B 5H1.

Appendix A

List of N.B. Fisheries

New Brunswick Fisheries

	Name	Address	# of Employees
1.	Albert & Sons	Neguac	seasonal
	Anglo-British	Caraquet	15
2.	Baie-St. Anne Co-op	Baie St. Anne	15
2a.	Assoc. Fisheries	Shippegan	300
3.	Bay Chaleur Packers	Bas Caraquet	150
	Baie Deschaleur	Caraquet	60
4.	Blanchar's Fish MAnuf.	Pigeon Hill	
4a.	Belle Bay Prod	Caraquet	230
5.	Blue Cove Packing	Blue Cove	50
6.	Brine, James Fish Pakers	Port Elgin	8
7.	Brine, Roger	Cap Pele	7
8.	Brunswick Fish Market	Wishart Point	150
9.	Buctouche Bay Oyster Co-op	Buctouche	5
10.	Cape Bald Pack.	Cap Pele	75
11.	Carapec Ltee	Caraquete	350
12.	Chamcook Sea Foods	St. Andrews	20
13.	Connors Bros.	Blacks Harbours *office	1000
14.	Connors Bros.	Shippegan	500
15.	Connors Bros.	Isle Aus Morts	
16.	Connors Bros.	Back Bay	200
17.	Connors Bros.	Seal Cove	150
18.	Connors Bros.	Fairhaven	200
19.	Connors Bros.	Wilsons Beach	100
20.	Connors Bros.	Caraquet	35
21.	Cormier & Leblanc	Cap Pele	150
22.	Cormier, Charles Omer	" "	5
23.	Cormier, Hector C.	" "	5
24.	Cormier Robert A.	" "	3
25.	Cormier Romeot	" "	15
26.	Cove Seafood	Woodwards Cove	30
27.	Duguay, Omer	Cap Pele	seasonal
28.	Gaudet & Ouellette	" "	15
29.	Gagnon, Edmond	Robichaud	75
30.	Gauthier Ltd.	Shippegan	125
31.	Gully Fish & Food	Shippegan	500
32.	Harvey & Bleumortier	Seal Cove	2

	Name	Address	# of Employees
33.	Helshiron Fisheries	Seal Cove	2
34.	Ingersoll, John E. & Son	Woodwards Cove	20
35.	Jackson Bros	Wilson Beach	25
36.	Jacob, Emile	Cap Pele	10
37.	Jacob, Philip	Petit-cap	3
38.	L'Association Co-op Des Decheurs	Lameque	550
39.	La Co-op Des Ostreiculture	Maisonnette	15
40.	Landry & Landry	Robichaud	120
41.	Landry, Theodore	Grand Anse	
42.	Leblanc, Elphege & Norbert	Cap Pele	8
43.	Lebalnc, Emile C	" "	75
44.	Leger, Leslie	" "	seasonal
45.	Lobster Trap Ltd.	St. Louis de Kent	5
46.	Maisonnette Seafood	Blue Cove	40
47.	Maisonnette	Maisonnette	35
48.	McGraw Fresh & Frozen	Tracadie	5
49.	Misty Island Fish	Woodward Cove	60
50.	National Sea	Shediac	600
51.	Neguac Shellfish	Neguac	100
52.	O'Neill, Bernard	Seal Cove	10
53.	Ouellette, Phillip	Cap Pele	6
54.	Produits Des Peches	Ste Marie-sur mer	80
55.	Richard, B.A.	Ste Anne de Kent	60
56.	Richard Fish Prod.	Richibucto Village	4
57.	Richibucto Village Co-op	" "	50
58.	Sandell Fisheries	Cap Pele	15
59.	Shediac Lobster	Shediac	100
60.	Savoie, Henri	Pigeon Hill	45
61.	SEafore Ltd.	Woodward Cove	
62.	Seapro Ltd.	Caraquet	13
63.	Small, James	Sea Cove	seasonal
64.	Small, F & J	Whitehead	
65.	Wayco Seafoods	Seal Cove	2
66.	West Morland	Cap Pele	150

Appendix B

Industrial Energy Survey Questionnaire

THE PROVINCE OF NEW BRUNSWICK
INDUSTRIAL ENERGY SURVEY

1. WHAT IS YOUR MONTHLY ENERGY CONSUMPTION?

Energy Source	Monthly Energy Consumption	Monthly Cost
a) Electricity (kWh)		
b) Fuel Oil (gallon/litre)		
c) Other (Specify) _____		

2. WHICH OF THE FOLLOWING EQUIPMENT IS USED FOR PROCESSING?

___ BOILERS ___ OVENS
___ KILNS ___ FURNACES
___ REFRIGERATION ___ OTHER (SPECIFY) _____

3. WHICH OF THE FOLLOWING PROCESSES ARE USED IN YOUR PLANT?

___ COOKING ___ EVAPORATING
___ PASTEURIZING ___ SOAKING
___ BLANCHING ___ HEATING
___ SCALDING ___ MELTING
___ STERILIZING ___ PROCESS HOT WATER
___ DRYING ___ WASHING/SANITIZING/CLEANING
___ BLAST FREEZING ___ CHILLING
___ ICE MAKING ___ OTHER (SPECIFY)

4. DO YOU REQUIRE ENERGY FOR PROCESSING DURING SUMMER MONTHS?

_____ YES/NO

5. PLANT OPERATIONS:

a) NO. OF HOURS PER DAY _____ (HOURS)
b) NO. OF OPERATING WEEKS PER YEAR: _____ (WEEKS)
c) SIZE OF PLANT: _____ (SQ. FT/SQ. METRE)

6. PLEASE CHEKC ANY OF THE FOLLOWINC ITEMS IF YOU ARE INTERESTED IN RECEIVING MORE INFORMATION ABOUT THEM:

___ HEAT RECOVERY EQUIPMENT ___ COGENERATION

Appendix C

List of companies contacted in
N.B. Food and Beverage industry

List of Companies contacted in the Food and Beverage Industry, New Brunswick

HUB MEAT PACKERS LTD. - Moncton

CANADA PACKERS LTD. - Sussex

BROOKE BOND FOODS LTD. - St. John

CHIPPIN BROS. LTD. - Fredericton

NADEAU POULTRY FARM LTD. - St.Francois de Madawaska

BAXTER DAIRIES LTD. - St. John

CAPITAL DAIRY FOODS LTD. - Fredericton

McCAIN FOODS LTD., - Florenceville

G.E. BARBOUR COMPANY LTD. - Sussex

CO-OP ATLANTIC - Moncton

EASTERN BAKERIES LTD. - St. John

LANE'S BAKERY LTD. - Moncton

KARNES KITCHEN LTD. - Woodstock

ATLANTIC SUGAR LTD. - St. John

GANONG BROS. LTD. - St. Stephen

CONNORS BROS. LTD. - Black's Harbour

NATIONAL SEA PRODUCTS LTD. - Shippegan

CARAPEC LTEE. - Caraquet

MOOSEHEAD BREWERIES LTD. - St. John

OLAND BREWERIES LTD. - St. John

MARITIME BEVERAGES LTD. - Moncton

NATIONAL SEA PRODUCTS LTD. - Shediac

L'ASSOCIATION COOPERATIVE DES PECHEURS DE L'ILE LTEE - Lameque

CONNORS BROS. - Shippegan

ASSOCIATED FISHERIES OF CANADA LTD. - Shippegan

GULLY FISH AND FOOD PROD. CO. LTD. - Shippegan

BELLE BAY PRODUCTS LTD. - Caraquet

CONNORS BROS. LTD. - Fairhaven, Deer Island

CONNORS BROS. LTD. - Back Bay

BAY CHALEUR PACKERS LTD. - Bas Caraquet

CORMIER & LEBLANC (1968) LTD. - Cap Pele

WESTMORLAND FISHERIES LTD. - Cap Pele

UNITED MARITIME FISHERMEN CO-OP - Richibucto

BRUNSWICK SEAFOOD LTD. - Cap Pele

CONNORS BROS. LTD. - Seal Cove, Grand Manan

LANDRY AND LANDRY (1975) LTD. - Robichaud

L.L. GAUTHIER & SONS CO. LTD. - Shippegan

SHEDIAC LOBSTER SHOP LTD. - Shediac

NEGUAÇ SHELLFISH CO. LTD. - Lower Neguac

MILLS SEAFOOD LTD. - Buctouche

CONNORS BROS. LTD. - Wilsons Beach, Campobello Island

BRUNSWICK FISH MARKET CO. LTD. - Val Comeau